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The SPRUCE BUDWORM SITUATION in MINNESOTA --1963

-- INTRODUCING THE OPERATION RECORDER AS AN EVALUATION TOOL --

Results of Survey & Control Methods

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U.S. Department of Agriculture

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PROLOGUE

THE SPRUCE BUDWORM SITUATION IN MINNESOTA - 1963

by

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This report summarizes the results of the 1963 spruce budworm control project and the aerial and ground surveys on the Superior National Forest; in addition, it indicates how the operation recorder survey can be used as an evaluation tool.

Cooperating on the aerial survey were the Superior National Forest, Duluth, Minnesota; the Beltsville Forest Insect Laboratory, Forest Service, U. S. Department of Agriculture, Beltsville, Maryland; the Ely Service Center, Superior National Forest, Ely, Minnesota; the Lake States Forest Experiment Station, Grand Rapids, Minnesota; the Minnesota Department of Agriculture, St. Paul, Minnesota; and the Nicolet National Forest, Rhinelander, Wisconsin.

The ground survey work was conducted by the Superior National Forest.

INTRODUCTION

History - The spruce budworm, Choristoneura fumiferana (Clem.) is one of the most destructive forest pests in the United States. In the eastern United States, major outbreaks of the spruce budworm have appeared at 40 to 70-year intervals since 1770 (9); 40 to 70 years is about the length of time required to mature a new stand of trees. Between 1910 and 1925 the budworm is said to have destroyed 200 million cords of balsam fir and red spruce in the forests of eastern United States and Canada (8). In Maine alone, between 1909 and 1919, the budworm destroyed 27 million cords of spruce and balsam, or enough timber to supply that state's pulp and paper industry needs for ten years (9). Similar figures are not available for Minnesota where timber losses and damage are heavy.

The infestation by the spruce budworm on the Superior National Forest has been present since 1954 (7). The outbreak extends across the northernmost section of Minnesota from International Falls south to Deer Lake and west to Tofte on Lake Superior. Defoliation first occurred in the northwestern section of this area and slowly spread southeastward with the resulting tree damage heaviest in the west and north.

Host Trees and Damage - The spruce budworm in Minnesota is a primary defoliator of balsam fir, Abies balsamea (L.) Mill., and white spruce, Picea glauca (Moench) Voss. Black spruce, Picea mariana (Mill.) B.S.P., is also attacked but to a relatively small degree; the budworm cannot sustain itself on this species because the tree's growth starts too late in the spring to supply suitable food for the young larvae (1). Some feeding may also occur on tamarack and pine but the damage is negligible (3).

The spruce budworm attacks white spruce and balsam fir with equal vigor but the resulting defoliation is more noticeable on balsam; the spruce's foliage is 3-4 times more dense than balsam. Studies by the Lake States Forest Experiment Station indicate that the spruce budworm exhibits an ovipositional preference for white spruce at a ratio of 2.3:1 over balsam (11).

The stands most susceptible to attack are those in which balsam fir predominates; this is especially true during heavy flowering of mature and overmature trees, because staminate flowers are a preferred food source for the young larvae (1,4).

An unsightly appearance, reduced growth and vigor, and eventual deformation or death are the results of sustained attacks by the spruce budworm. As the budworm usually eats only the current season's foliage, several successive years of heavy defoliation must occur before serious tree mortality results. Often, trees weakened by several years of heavy defoliation are easily invaded by various bark boring insects (1).

AERIAL SURVEYS

Method - The operation recorder method of tabulating defoliation and tree mortality has been used from 1956 to 1963. It has proved to be a most efficient survey vehicle. Organizational changes and poor weather were responsible for the lack of a survey in 1962.

This method of survey requires at least two observers in an aircraft to transfer visual observations of defoliation and mortality to a moving paper chart (operation recorder) via electrically activated pens (5,6). Each observer (one on each side of the aircraft) operates a keyboard that has six switches. Each switch is electrically connected to the operation recorder and captioned according to the information required on the survey. When the observer's switch is held down, the electrical circuit is closed; this energizes an electromagnet which moves the pen across the chart. Each observer uses a viewer held against the window by a suction disc. The viewer restricts the observer's vision to a constant strip (1 chain wide per 100 feet of altitude) in order to maintain the chosen degree of sampling.

The pilot maintains a constant speed and altitude over a predetermined flight line. A navigator maintains the course and records the landmarks on the operation recorder chart. Recording the landmarks in relation to the defoliation and mortality is essential; it allows compensation for air speed discrepancies when the data is plotted.

The operation recorder permits a correlation between time and distance flown, and time and distance recorded on the operation recorder chart. Observations made from the moving aircraft can be precisely located and measured on the recorder tape then later transferred to a large-scale plotting map. On the map, different colors are used for the various defoliation categories; symbols are used to denote the two categories of mortality on the 1963 survey.

Appendix D was developed from the 1963 plotting map by circling the areas in which the major portion of the plotted data fell within one of the four defoliation categories. A similar method was used to show mortality (Appendix E). Appendices A, B, and C show defoliation for 1959, 1960, and 1961. By comparing these with Appendix D, the migration of the spruce budworm and the subsequent defoliation of the spruce-fir type can be readily seen. In any assessment of Appendices A, B, C, D, and E, it should be kept in mind that the areas shown for each defoliation or mortality category does not necessarily mean that all spruce-fir within this area had that degree of defoliation or mortality; it merely indicates that a major portion of the type acreage falls within that category. Other degrees of defoliation may also occur within each area, but they occupy less acreage (2).

The 1963 aerial survey crew consisted of two pilots, four trained observers, and four survey trainees. Approximately 24 hours of flying time were required to orientate the trainees and complete the survey. Eighteen hours

were flown by the Beltsville's Cessna 195 and six hours were flown by the Ely Service Center's Beaver. Both planes were stationed in the Ely area. The per-acre cost of the survey was $.00075, a most economical figure considering the quality and quantity of the information collected.

The survey was carried out during the latter part of July and the first part of August. This is an ideal time for a defoliation survey as the budworm is finished feeding, and enough time has elapsed to discolor the dead, partially eaten needles though not enough time for them to have dropped.

The operation recorder type survey has distinct advantages over the sketch-mapping method of aerial surveying. Primarily it affords a precise method of recording various defoliation and mortality levels. Without repeated flights over an area, it would be extremely difficult with the sketch-mapping technique to obtain an equal degree of precision. With the operation recorder, data is quickly and efficiently accumulated. The different degrees of defoliation and mortality must be recorded if year-to-year changes in budworm populations are to be determined and future trends predicted. To only record the areas of heavy defoliation by sketch-mapping is to ignore the possibility that control measures may be necessary before the development of a major infestation. Presuppression may prove to be considerably cheaper than suppression of a major outbreak.

Results - Foliage color, and the distance the color progressed down the crown were the criteria used for separating the different degrees of defoliation. This was true except for the severe defoliation class where thinness of foliage was an additional consideration. Defoliation, mortality, and type specifications used by the observers for recording data were as follows (2):

1. No current defoliation - overall blue-greenish appearance of all new foliage.

2. Light current defoliation - yellowish to light brownish appearance of upper crown. May have many lightly defoliated trees in which no defoliation can be detected from the air. Any discernible defoliation is classified as light.

3. Moderate-heavy current defoliation - reddish to brownish appearance of over 50 percent of crown; frequently a grayish appearance in the very top of the crown. May also contain moderately defoliated individual trees or groups of trees with reddish appearance of top and up to 50 percent of the upper crown.

4. Severe defoliation - grayish to purplish appearance over the entire tree and stand; caused by two or more years of heavy defoliation with heavy current defoliation and a brownish appearance along tips of all branches.

5. Type - white spruce and balsam fir. If no trees of these species were seen, the timber was considered out of type and no keyboard switches were depressed. Two switches were allocated to indicate degree of type: (a) 20-50% spruce-fir type; (b) 51-100% spruce-fir type.

6. Mortality - two switches were allocated to indicate amount of mortality in spruce-fir type: (a) 10-50% mortality; (b) 51-100% mortality.

The following, Table 1, is the summary of the 1963 spruce budworm aerial survey of the Superior National Forest and adjacent State and private lands:

Table 1 - 1963 Aerial Survey Data

Defoliation Data

Total acreage in survey area	-	2,677,704				
Total acreage actually sampled	-	69,379				
Percent sample - 2.59%						
Blowup factor -38.6						
		Area Sampled		Blowup Factor		Total Area
No current defoliation	-	12,266 A.	x	38.6	=	473,468 A.
Light current defoliation	-	3,562 A.	x	38.6	=	137,493 A.
Moderate-heavy current defoliation	-	3,384 A.	x	38.6	=	130,622 A.
Severe defoliation	-	3,010 A.	x	38.6	=	116,186 A.
Total acreage in type	-	22,222 A.	x	38.6	=	857,769 A.

Type Data

Total acreage in survey area	-	2,166,531 A.				
Total acreage actually sampled	-	44,094 A.				
Percent sample - 2.04%						
Blowup factor -48.8						
20-50% spruce-fir type	-	8,710 A.	x	48.8	=	425,048 A.
51-100% spruce-fir type	-	7,962 A.	x	48.6	=	388,546 A.

Mortality Data

Total acreage in survey data	-	2,025,408 A.				
Total acreage actually sampled	-	42,196 A.				
Percent sample - 2.08%						
Blowup factor -48.0						
10-15% mortality in spruce-fir	-	2,338 A	x	48.0	=	112,224 A.
51-100% mortality in spruce-fir	-	2,722 A.	x	48.0	=	130,656 A.

The aircraft flew at an altitude of 500 feet; this means that a strip five chains wide was being observed on each side of the aircraft through the restrictive viewers. Because the flight lines were placed three miles apart over most of the area, each observer (one recording defoliation data and the other recording type and mortality data) actually sampled about two percent of the total area being surveyed.

During part of the survey, mortality and type sampling was suspended and defoliation data was recorded from both sides of the aircraft; this explains why the defoliation sampling level was different from the type and mortality

data. It also explains why the total acreage figures are not the same for the three groups of data - the mortality figure is less than the type figure because mortality was only recorded in the northern portion of the forest where budworm-caused mortality is greatest. In addition, the total acreage in type, from the defoliation data, does not agree with the combined type acreage.

There are three reasons for this: there was more land surveyed for the defoliation data and therefore the total type derived from the survey was correspondingly higher; the percentage of spruce-fir type to non-type, where defoliation data was recorded from both sides of the aircraft, was higner than the percentage where type data was recorded on one side and defoliation on the other. The two sets of type data were recorded by different people on different sides of the aircraft, and although they would tend to be the same over the full survey, it is unlikely that they would be exactly the same.

The percent sample is computed from the total area viewed in relation to the gross area of the survey, as measured by accumulating the land area in two strips $1\frac{1}{2}$ miles wide, on each side of the flight line. To obtain the total acreage in each category sampled, multiply the blowup factor (100% ÷ sample % = blowup factor) by the area sampled in each respective category.

If the sketch-mapping method of aerial survey had been used, none of the precise information collected on this survey would have been available. It is possible to delineate different degrees of defoliation during a sketch-map survey by use of colored pencils. The acreages involved in each category can be determined by the use of a dot grid or planimeter. However, survey precision is necessarily decreased by the observer's difficulty in distinguishing four different degrees of defoliation while at the same time drawing them on a map. The same is also true when recording type and mortality data.

With sketch-mapping, in order to properly evaluate the degrees of defoliation and to more accurately delineate the limits of the infestation, extensive ground surveys are necessary. With the operation recorder survey only incidental ground surveys are necessary; the information is quickly and accurately recorded with the flip of a switch. All that remains is to translate the chart data into actual acreage figures and to relocate it on a plotting map. Although the operation recorder is a very effective survey tool, the information obtained from it is only as reliable as the observers who use it. In order to assure maximum survey efficiency on the Superior National Forest, a trained, permanent crew has been established.

The 1963 aerial survey showed a considerable decrease in the area of severe defoliation as compared to 1961 (Table 2); this has been brought about partly by the reduction, through mortality, of susceptible spruce-fir stands. The moderate-heavy defoliation category has decreased greatly for 1963 and the infestation has retreated. The westward spread of the infestation has been checked. Even though large areas show no appreciable defoliation for 1963 where light, moderate and even heavy defoliation had been recorded earlier, continued heavy defoliation can be expected on certain areas for 1964.

Table 2. - Defoliation summary by acreages of spruce-fir type

	1961	%	1963	%
None-to-light current defoliation	428,600	42	611,000	71
Moderate-to-heavy current defoliation	366,300	35	130,600	15
Severe defoliation	240,800	23	116,200	14
Spruce-fir type surveyed (total)	1,035,700	100	857,800	100

The aerial survey was supplemented by ground surveys.

GROUND SURVEY

Method - During 1963, ground surveys were undertaken throughout the Superior National Forest to obtain a comprehensive, current picture of the spruce budworm population levels. The ground surveys consisted of egg mass collections and incidental visual estimates of current defoliation in the vicinity of each collection point. A visual estimate of defoliation from the ground supplements the aerial survey. It should be kept in mind, however, that the ground survey dealt with defoliation predictions and current population levels while the aerial survey dealt with the extent and degrees of present defoliation. Ground surveys alone cannot do the job because of the vast areas involved and because the lighter degrees of budworm defoliation are much easier to detect from the air.

Egg mass collections were made by clipping two 15-inch branch tips from mid-crown on opposite sides of dominant and codominant balsam fir. Three trees were selected at each collecting point. The collection points were the same points that were sampled in 1962, plus others located in areas of high special-use value, where precise information was desired. Branches collected for egg mass data were taken to the Kawishiwi Field Laboratory and refrigerated until examinations could be made by two women trained to differentiate current egg masses from the previous year's.

In the analysis of the egg mass data, the average number of egg masses per 15-inch branch sample was determined for each collecting point and by use of Table 3 (2), the defoliation prediction for 1964 was determined (Appendix H).

Table 3. - Probability of different degrees of defoliation on balsam fir at any locality in northeastern Minnesota for the following year based on the average number of egg masses per 15-inch twig per collecting point.

Average number of egg masses per 15-inch branch tip	Number of chances in 100 for the following degree of defoliation 1/			
	None	Light	Moderate	Heavy
0-0.2	43	45	9	3
0.3-0.5	5	58	21	16
0.6-1.0	2	14	42	42
1.1-5.0		5	23	72
5.1-10.0			6	94
10.0 and up				100

1/ Defoliation classification: light - 5 to 25 percent defoliated; moderate - 30 to 50 percent defoliated; heavy - 55 percent or more defoliated.

Results - Appendix H is a summary of the egg mass survey. Of the 70 egg mass plots taken, only 10 indicated moderate-heavy defoliation for 1964 while 44 indicated light-moderate defoliation; 15 indicated no defoliation. In general, this indicates a much improved situation for next year.

EVALUATION

Natural biological factors - parasites, predators, and disease - that tend to keep the spruce budworm in check during endemic periods do not play a very important role in controlling the budworm when ecological conditions are favorable for its increase. Aerial application of DDT continues to be the only effective known means of control. At the present time control measures are instituted only on high-use recreational areas.

Chemical application is directed at the budworm's third larval instar. Although a decrease in the percentage of insect mortality results, it has been shown that the maximum amount of foliage is saved when control is applied 7 to 8 days after the third instar peak. Because the larvae are not feeding voraciously at this time, a population reduction of 68 percent is considered sufficient to save 70-75 percent of the new foliage (10).

Proposed 1964 Spray Blocks - The project proposal for 1964 was initially set up by the biological evaluation made by the area entomologist. Mainly, this evaluation consisted of four parts: past defoliation history; the operation recorder survey; the egg mass survey; the incidental ground observations which were carried out at the time of the egg mass survey and throughout the field season. Field surveillance reports also made an important contribution to the evaluation. The original proposal was subsequently tempered by timber, recreation, wildlife, and water resource considerations to determine which particular resource was apt to suffer most from the budworm outbreak, and what effect suppression would have on resources and public relations. Suppression cost estimates were weighed against the resource benefits which would be realized from control, and the final recommendations were made. See Appendix G and the following, Table 4.

Table 4. - Proposed 1964 Spray Blocks

Block I	Gunflint	425 Acres
" II	Lake One	465 Acres
" III	Kawishiwi	295 Acres
" IV	Pictured Rocks	340 Acres
" V	Meander Lake	375 Acres
" VI	Jeanette Lake	710 Acres
		2,610 Acres

Block I is located on Gunflint Trail; Block II is located on Fernberg Road; Blocks IV, V, and VI are located on Echo Trail. These roadways are heavily traveled approach ways to the unique Boundary Waters Canoe Area. Block III is an extensively used research and multiple use demonstration area.

CONTROL

If left unchecked, the spruce budworm could destroy the majority of spruce-fir types on the Superior National Forest. In the past, chemical control measures have been directed at protecting mature, high value spruce-fir stands and the better immature spruce-fir stands. The decline in the balsam fir market, however, coupled with the tremendous spread of the infestation, has made it economically unfeasible to continue widespread control. As a result, only high-use recreational areas have been considered for control. Spraying can be justified on small, high-use recreational areas because the loss is readily evidenced by a decrease in public usage; if these recreational areas are not maintained, the multiple use image of the Superior National Forest will be greatly diminished.

1963 Spray Blocks - As a result of our evaluation procedures, aerial spraying with DDT was used on 3,369.3 acres of spruce-fir types in recreational areas on the Superior National Forest (Appendix F). Because of the close proximity of the spray areas to high value fishing waters and private land, it was decided to reduce the amount of DDT from 1 lb. to $\frac{1}{2}$ lb. per acre. A helicopter was used. The slower speed and greater maneuverability of the helicopter resulted in a more precise placement of the spray material than would have been possible with a fixed wing aircraft. No reports of damage to fish and wildlife were received.

Before spraying, budworm population check lines were established in every spray block. Six to ten days after each block was sprayed, the larval population was recounted on these check lines.

Check trees were also established in non-sprayed areas to determine if budworm mortality was due to reasons other than spraying. These areas showed no significant drop in the budworm population. The results obtained on the sprayed areas are as follows, Table 5:

Table 5. - 1963 Spray Blocks

Unit and Block	Acres	% Mortality Obtained
Unit I		
Block 1 (Meander Creek)	358.3	78
Block 2 (Fenske Lake)	335.3	90
Block 3 (Kawishiwi Experiment Station)	416.3	76
Block 4 (Moose Lake)	51.0	78
Block 5 (Birch Lake)	117.0	83

Table 5. - 1963 Spray Blocks (continued)

Unit and Block		Acres		% Mortality Obtained
Unit II				
Block 1 (Flat Horn)		280.0		96
Block 2 (Windy Lake)		242.5		66
Block 3 (Sawbill Road)		501.7		82
Unit III				
Block 1 (Trails End)		265.7		100
Block 2 (Iron Lake)		374.3		67
Block 4 (Gunflint Trail)				
Block 5 (East Bearskin)		627.2		97
	Total	3,569.3	Average	83%

SUMMARY

The operation recorder type aerial survey is especially suited to surveying mortality and varying degrees of defoliation caused by the spruce budworm. Considering the quality and quantity of data obtained, it is an extremely economical method of survey. With trained personnel it is a comparatively easy and rapid survey method, and its possibilities for collecting additional information are limitless.

The spruce budworm, Choristoneura fumiferana (Clem.) is an extremely injurious forest defoliator that has the capability, if left unchecked, of destroying the spruce-fir types on the Superior National Forest. Because of the balsam fir market condition at the present time, no attempt is being made to control the budworm on large tracts of spruce-fir timber. Rather, control measures are directed at high-use recreational sites to keep these areas green until natural control factors such as weather, parasites, predators, starvation, and the insect's own population dynamics may reduce the current outbreak to an endemic state.

The 1963 aerial and ground surveys on the Superior National Forest indicate that defoliation will be less intense than in recent years although continued heavy defoliation and subsequent mortality by the budworm on certain areas can be expected. Generally, the areas of heavier defoliation have decreased and infestation has retreated; current defoliation was not detected as far south, or as far east as in 1961.

APPENDIX

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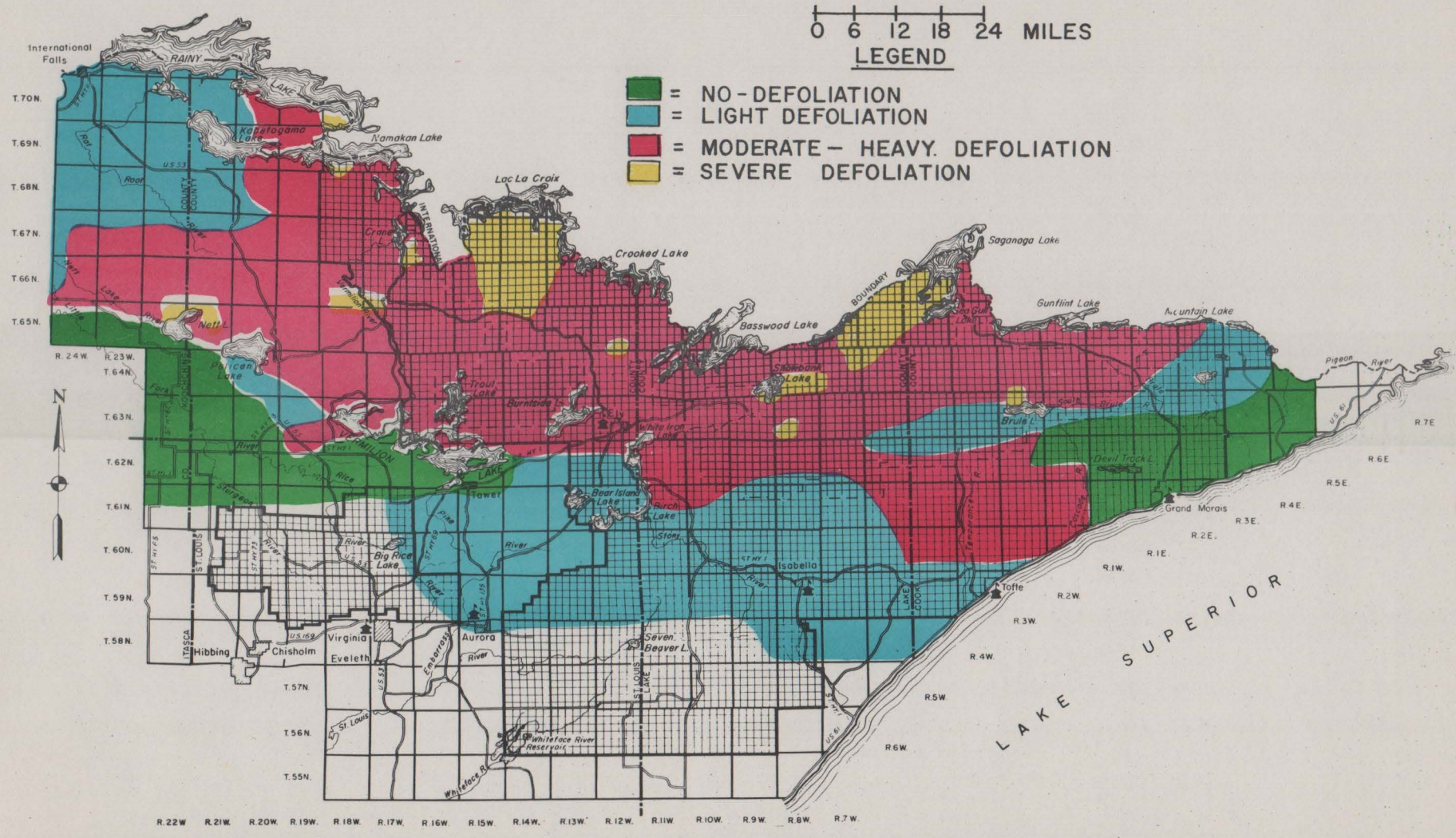
APPENDIX A

SPRUCE BUDWORM DEFOLIATION 1959
SUPERIOR NATIONAL FOREST
MINNESOTA



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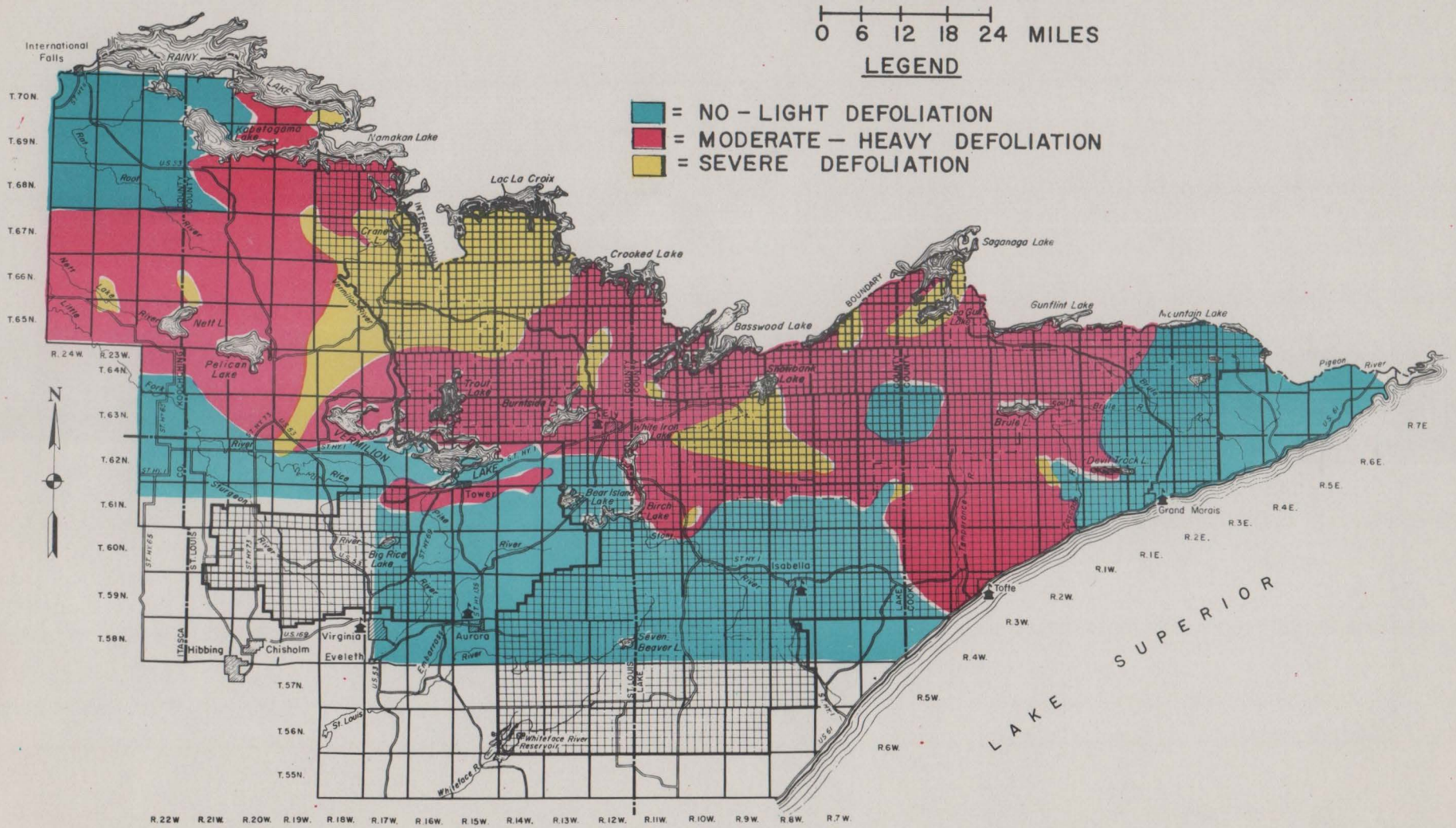
APPENDIX B

SPRUCE BUDWORM DEFOLIATION 1960
SUPERIOR NATIONAL FOREST
MINNESOTA

0 6 12 18 24 MILES

LEGEND

= NO – LIGHT DEFOLIATION
= MODERATE – HEAVY DEFOLIATION
= SEVERE DEFOLIATION



TYPICAL TWP.

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

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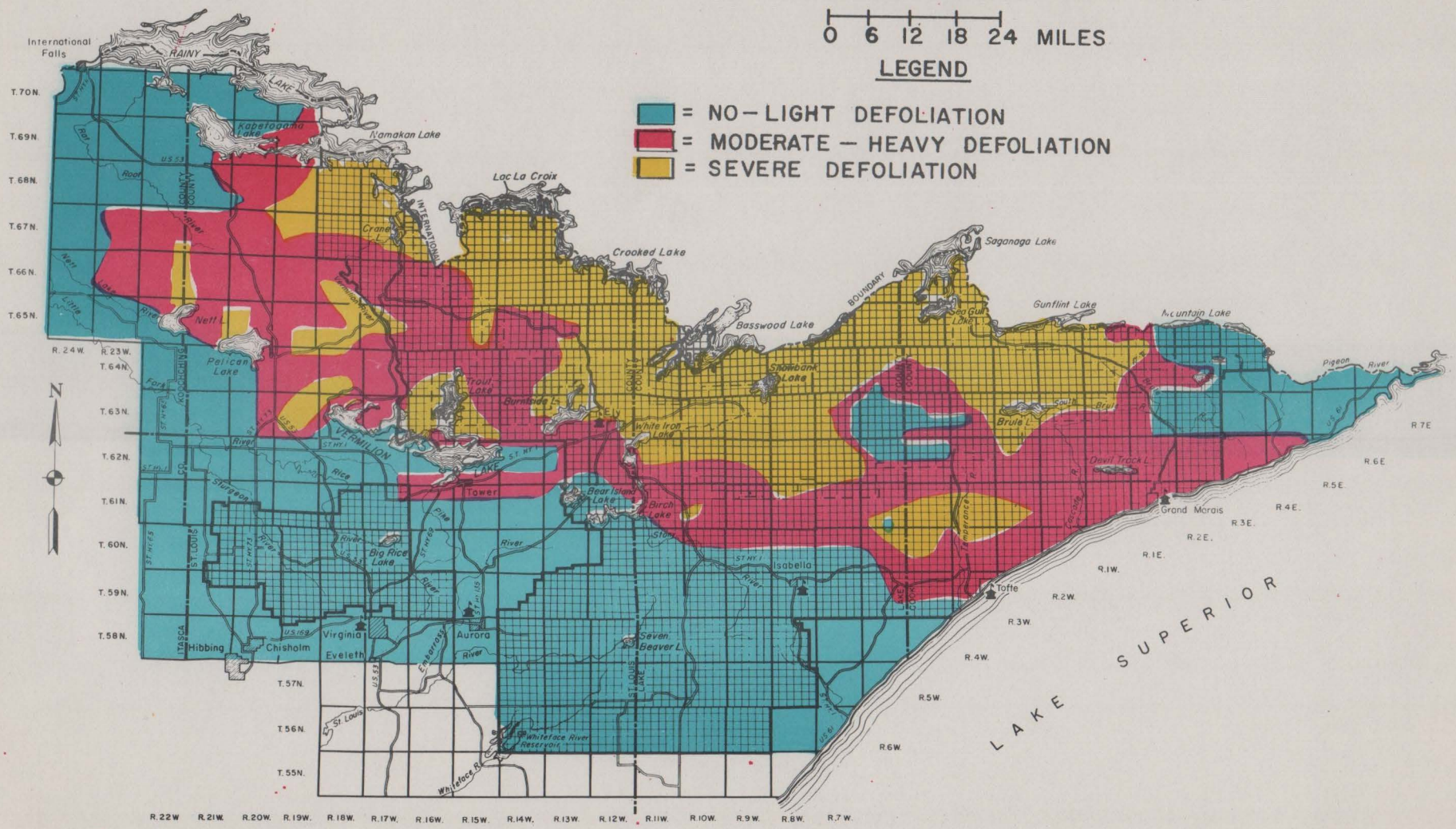
APPENDIX C
SPRUCE BUDWORM DEFOLIATION 1961
SUPERIOR NATIONAL FOREST
MINNESOTA

0 6 12 18 24 MILES

LEGEND

= NO – LIGHT DEFOLIATION
= MODERATE – HEAVY DEFOLIATION
= SEVERE DEFOLIATION



TYPICAL TWP.

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
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31	32	33	34	35	36

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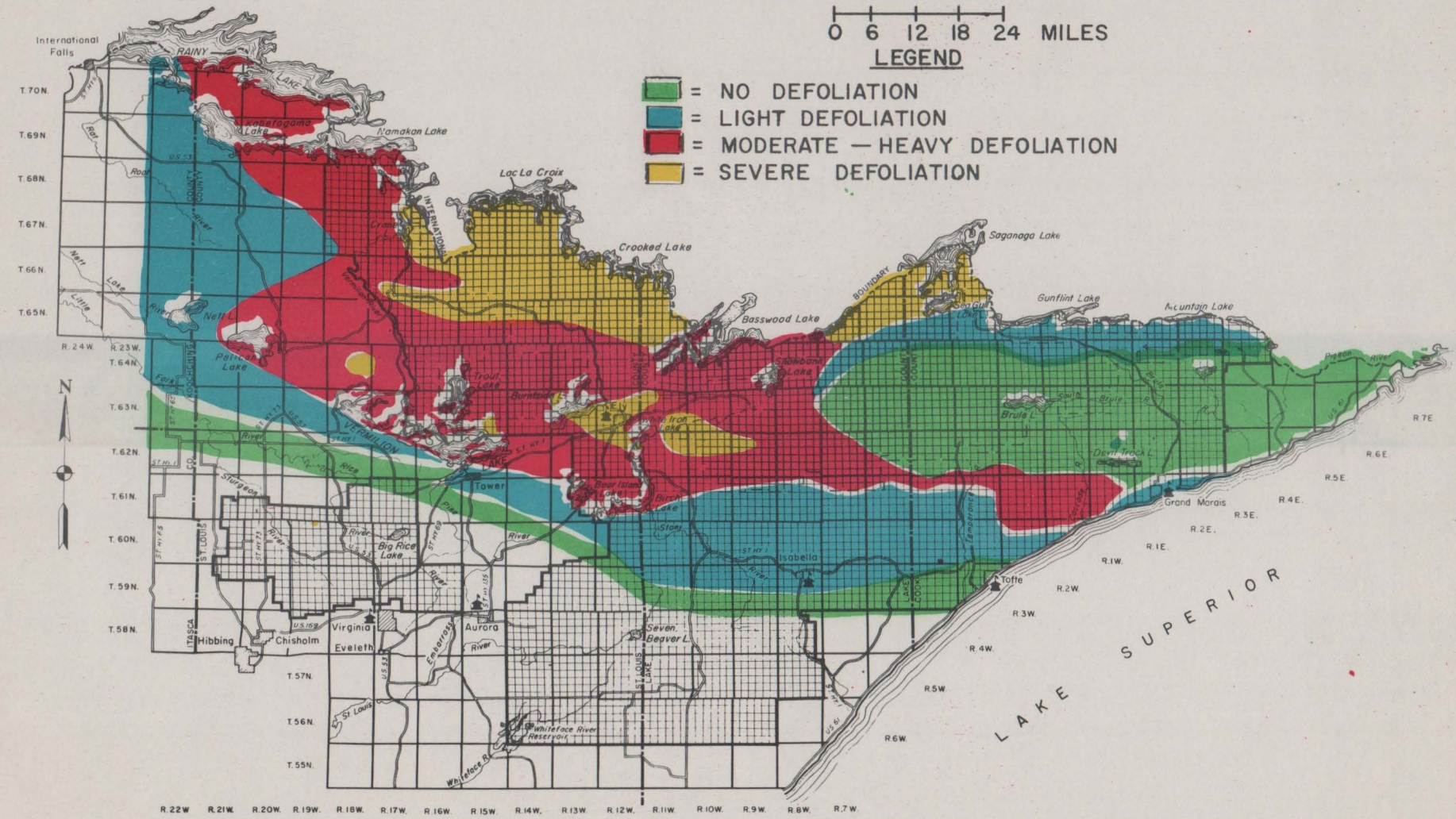
APPENDIX D
SPRUCE BUDWORM DEFOLIATION 1963
SUPERIOR NATIONAL FOREST
MINNESOTA - 1963



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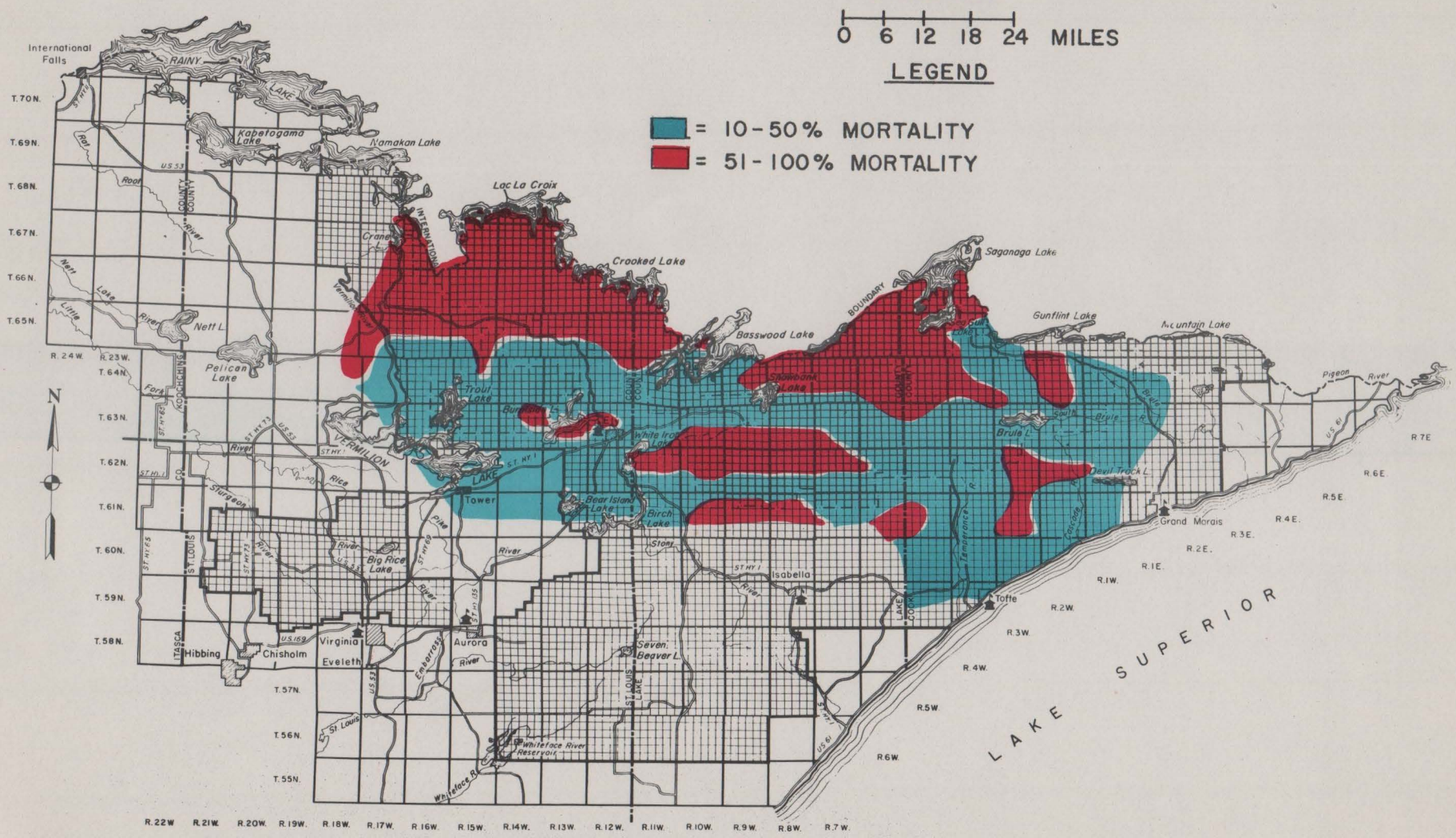
APPENDIX E
SPRUCE FIR MORTALITY 1963
SUPERIOR NATIONAL FOREST
MINNESOTA



TYPICAL TWP.

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
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31	32	33	34	35	36

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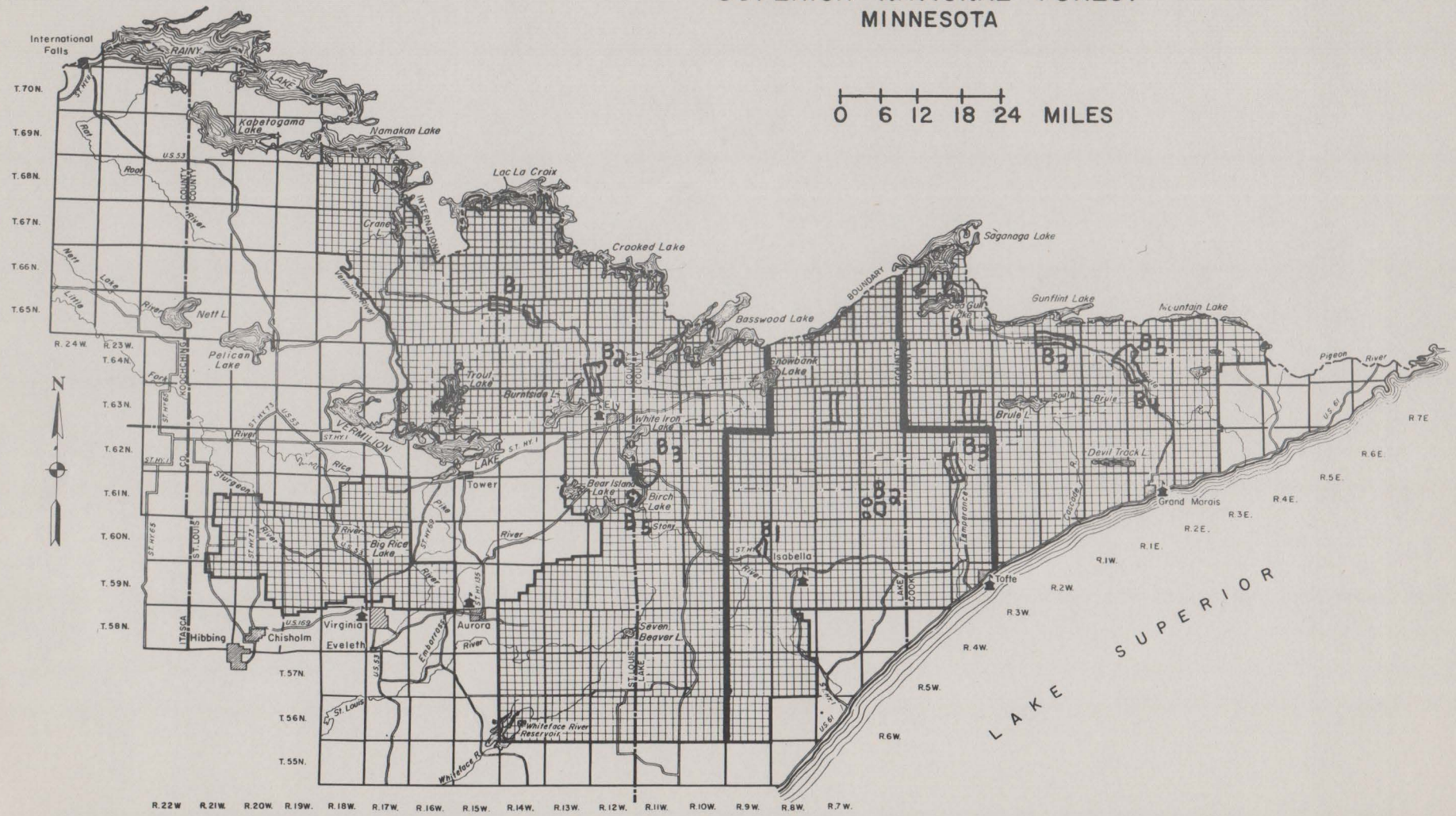
APPENDIX F

SPRUCE BUDWORM SPRAY BLOCKS 1963
SUPERIOR NATIONAL FOREST
MINNESOTA



TYPICAL TWP.

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
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31	32	33	34	35	36

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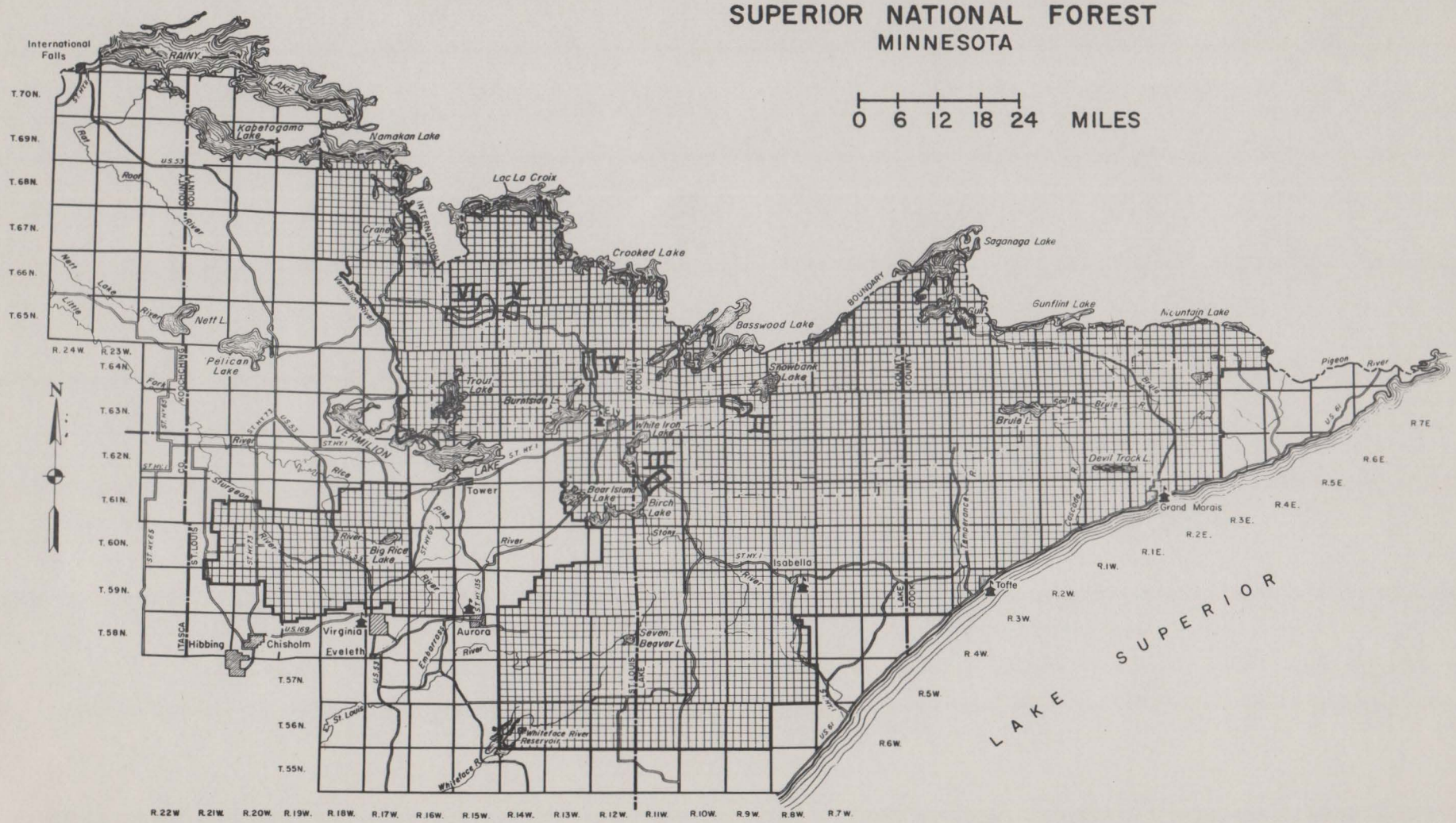
CONTACT
FOREST SUPERVISOR
U. S. FOREST SERVICE
DULUTH, MINNESOTA

APPENDIX G

PROPOSED SPRUCE BUDWORM SPRAY BLOCKS 1964 SUPERIOR NATIONAL FOREST MINNESOTA



TYPICAL TWP.

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

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APPENDIX H - Egg Mass Survey Data

Location				Ave. No. of Egg Masses/15" Sample	Current Defoliation 1963	Predicted Defoliation 1964
Plot	T.	R.	Sec.			
1.	61N	2W	15	0	Moderate	Light
2.	61N	2W	2	0	"	"
3.	62N	2W	14	0	None	None
4.	62N	1W	21	0	"	"
5.	63N	1E	15	0	"	"
6.	63N	1E	36	0	"	"
7.	64N	1E	25	0	"	"
8.	64N	1E	25	0	"	"
9.	64N	1E	31	0	"	"
10.	64N	1W	14	0	Light	Light
11.	64N	1W	1	0	"	"
12.	64N	1W	3	0	"	"
13.	65N	2W	31	.17	"	"
14.	65N	3W	33	0	"	"
15.	65N	3W	31	0	"	"
16.	65N	3W	28	0	"	"
17.	65N	4W	27	0	"	"
18.	65N	4W	15	.17	Heavy	Moderate-heavy
19.	66N	4W	32	.17	"	" "
20.	66N	4W	29	0	Light	Light-moderate
20A.	60N	3W	3	0	Moderate	" "
21.	60N	4W	8	0	Light	Light
22.	62N	4W	19	0	None	"
23.	61N	4W	30	0	Light	"
24.	61N	4W	34	0	"	"
25.	61N	3W	23	0	Moderate	"
26.	61N	3W	15	.33	"	Light-moderate
27.	59N	5W	9	0	None	None
28.	59N	6W	11	0	Light	Light
29.	59N	11W	24	0	"	"
30.	60N	10W	32	0	"	"
31.	64N	12W	30	0	Moderate	"
32.	64N	12W	7	.50	"	Moderate
33.	65N	13W	19	0	Heavy	Light-moderate
34.	62N	11W	33	.33	Moderate	Moderate
35.	61N	11W	5	0	"	Light
36.	61N	10W	18	0	"	"
37.	61N	10W	30	.33	Light	Light-moderate
38.	63N	10W	12	.67	Moderate	Moderate-heavy
39.	63N	11W	10	0	Heavy	Moderate

APPENDIX H (continued)

Location				Ave. No. of Egg Masses/15" Sample	Current Defoliation 1963	Predicted Defoliation 1964
Plot	T.	R.	Sec.			
39A.	63N	9W	8	.17	Moderate	Moderate-heavy
40.	63N	9W	16	.33	"	" "
41.	61N	17W	14	.33	None	Light
42.	61N	17W	23	.17	"	"
43.	59N	10W	1	0	Light	"
44.	59N	9W	5	0	"	"
45.	59N	9W	9	0	"	"
46.	59N	9W	29	0	"	"
47.	59N	9W	12	0	"	"
48.	58N	8W	23	0	None	None
49.	59N	8W	33	0	"	"
50.	58N	9W	26	0	"	"
51.	58N	10W	36	0	"	"
52.	57N	10W	31	0	"	"
52A.	58N	11W	12	0	"	"
53.	65N	15W	6	.50	Heavy	Heavy
54.	65N	15W	2	2.17	"	"
55.	64N	9W	28	0	Moderate	Light
56.	62N	8W	35	.17	"	Moderate
57.	59N	6W	34	0	None	None
58.	61N	6W	2	0	"	Light
59.	60N	7W	26	0	Light	"
60.	60N	4W	33	0	"	"
61.	60N	8W	3	.17	"	"
62.	62N	1E	14	0	None	None
I.	62N	11W	26	1.5	Moderate	Heavy
II.	61N	11W	10	0	"	"
III.	59N	8W	11	0	Light	Light
IV.	62N	11W	31	0	Moderate	Moderate
V.	65N	14W	9	.50	Heavy	Moderate-heavy